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# Guiding Attention Aids the Acquisition of Anticipatory Skill in Novice Soccer Goalkeepers

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**Purpose:** The ability to anticipate the actions of opponents can be enhanced through perceptual-skill training, though there is doubt regarding the most effective form of doing so. We sought to evaluate whether perceptual-skill learning would be enhanced when supplemented with guiding visual information. **Method:** Twenty-eight participants without soccer-playing experience were assigned to a guided perceptual-training group ( $n = 9$ ), an unguided perceptual-training group ( $n = 10$ ), or a control group ( $n = 9$ ). The guided perceptual-training group received half of their trials with color cueing that highlighted either the key kinematic changes in the kicker's action or the known visual search strategy of expert goalkeepers. The unguided perceptual-training group undertook an equal number of trials of practice, but all trials were without guidance. The control group undertook no training intervention. All participants completed an anticipation test immediately before and after the 7-day training intervention, as well as a 24-hr retention test. **Results:** The guided perceptual-training group significantly improved their response accuracy for anticipating the direction of soccer penalty kicks from preintervention to postintervention, whereas no change in performance was evident at posttest for either the unguided perceptual-training group or the control group. The superior performance of the guided perceptual-training group was preserved in the retention test and was confirmed when relative changes in response time were controlled using a covariate analysis. **Conclusions:** Perceptual training supplemented with guiding information provides a level of improvement in perceptual anticipatory skill that is not seen without guidance.

**Keywords:** anticipation, penalty kick, perceptual-skill training, sport

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Skilled perception is an important aspect of expertise in sport (Abernethy, Thomas, & Thomas, 1993; Starkes & Allard, 1993). This is particularly the case in sports like soccer where the fast decision-making and anticipation of goalkeepers is often relied on to win (or save) a match. The

penalty kick in soccer is often struck in excess of 75 km/hr, which gives the goalkeeper as little as 400 ms to intercept the ball (Kuhn, 1988). Under these types of time constraints, it is vital that goalkeepers make use of the advance postural cues inherent in the movement pattern of the kicker to increase the probability of successfully saving a penalty kick. Players must not only have honed their physical skills and movements, but they may also need an optimal level of visual-perceptual skill to underpin successful performance (Starkes & Allard, 1993). To this end, it is important to develop a fundamental understanding of the way visual information from the kicker can be used by soccer goalkeepers to effectively respond to and execute more successful interceptive movements.

Research into applied motor behavior has most commonly relied on the expert–novice paradigm to identify the perceptual-cognitive characteristics of skilled individuals; this research has established that skilled athletes are better at predicting the actions of their opponents due to their ability to effectively pick up advance visual cues from an opponent's movement kinematics (Abernethy & Russell, 1984; Jones & Miles, 1978; Savelsbergh, Williams, van der Kamp, & Ward, 2002). These findings have been supported by reports that skilled athletes may also possess more efficient visual search strategies when viewing the movement of an opposing player (Abernethy, 1990; Williams, Davids, Burwitz, & Williams, 1994). Empirical evidence suggests that skilled soccer players use more effective search strategies that allow them to fixate on the more informative areas of the display (Helsen & Pauwels, 1992; Kim & Lee, 2005; Savelsbergh, van der Kamp, Williams, & Ward, 2005). In particular, expert goalkeepers tend to spend more time prior to the availability of ball flight fixating on the kicking leg, nonkicking leg, and the ball, particularly at or immediately prior to the moment of foot–ball contact (though see Dicks, Button, & Davids, 2010). The superior anticipatory skills exhibited by expert athletes have led many to question how these skills are developed, whether they can be trained, and if so, what form(s) of training may be the most beneficial to ensure that anticipatory skills are learned efficiently and that they produce enhancements in on-field performance (Farrow & Abernethy, 2002; van der Kamp, Rivas, van Doorn, & Savelsbergh, 2008; Williams, Ward, Knowles, & Smeeton, 2002). The differences evident in information pick-up and in visual search strategy between experts and novices suggest that there may be potential to accelerate the acquisition of expertise by novices by developing training approaches to emulate the gaze behavior and information pick-up strategies of expert players.

In recent years, a growing number of interventions have been performed by sport and exercise psychologists to identify whether the anticipatory skills of athletes can be enhanced through perceptual training. For example, Farrow, Chivers, Hardingham, and Sachse (1998) found significant improvements in the anticipatory ability of tennis players

following 4 weeks of simulation training. They found faster response times (RTs) following perceptual training, reflecting an improvement in anticipatory performance. Similarly, Abernethy, Wood, and Parks (1999) sought to enhance the anticipatory ability of novice racquet-sport players through perceptual training using a program of 16 intervention sessions held during a 4-week period. The perceptual-training group significantly improved their ability to judge both shot direction and depth on the basis of information available prior to racquet–ball contact, while no such improvements were found in control groups who took part in other sport-related activities. Similar forms of perceptual training have been shown to be effective across a range of sporting tasks, including soccer goalkeeping (e.g., McMorris & Hauxwell, 1997; Poulter, Jackson, Wann, & Berry, 2005).

Having established that anticipatory skills can be enhanced by perceptual-skill training, more recent studies have sought to determine the most effective and time-efficient means of enhancing perceptual skill. It is possible that the anticipation of an outcome is learned simply through the repetitious observation of that movement pattern; however, most perceptual-training studies have sought to provide a stimulus to “teach” the observer the most useful information to use in anticipating an outcome. The majority of early studies sought to explicitly teach the specific information believed to be used by skilled athletes (e.g., Abernethy et al., 1999), although subsequent studies (e.g., Farrow & Abernethy, 2002; Smeeton, Williams, Hodges, & Ward, 2005) have tended to use more implicit means of training in an attempt to enhance skill retention without participants necessarily developing explicit knowledge about how, and from where, they extract critical information. A “guided discovery” approach using cue highlighting (e.g., Franks & Harvey, 1997) has been advocated to guide participants toward the key sources of information without providing explicit instructions about the type of information to be observed in those areas. It is not yet clear, however, whether these forms of guided discovery training provide advantages above and beyond those achievable by a simple program of training without any guided information.

The few attempts that have been made to assess the efficacy of “guided discovery” approaches using various forms of cue highlighting have resulted in somewhat conflicting and ambiguous findings. Hagemann, Strauss, and Cañal-Bruland (2006) used a transparent colored patch to highlight the location(s) of essential information for anticipation of the direction of overhead shots in badminton. Novices given such training performed better after training, and after a retention period, they performed better than novices given no training, but this advantage was not reproduced for more skilled players. Further, at the conclusion of the training period, the improvement in the performance of novices trained with color cueing was no

better than the improvement found for participants who viewed the same training clips without color cueing; intriguingly though, color cueing provided a distinct training advantage when performance was retested on a delayed retention test.

Abernethy, Schorer, Jackson, and Hagemann (2012) examined the efficacy of color cueing in improving anticipatory skill in a European handball goalkeeping task. In direct contrast to the improvements in learning found for three separate groups given (a) explicit rules to guide anticipation, (b) verbal direction toward the location of the critical anticipatory cues, or (c) an implicit pattern-matching intervention, no training effect was found for participants trained with color cueing. The change in performance for the group given color cueing was no better than a control group who performed no training, irrespective of whether testing was compared immediately after the training intervention or at a retention test 5 months after the intervention.

Savelsbergh, van Gastel, and van Kampen (2010) examined the effectiveness of directing visual attention to informative body areas for the anticipation of soccer penalty kicks. The performance of a perceptual-training group who viewed film clips with the relevant cues for anticipation highlighted on screen was compared to that of a group who saw the same clips without highlighting and to a control group given no training. The areas highlighted for the perceptual-training group were those corresponding to the location of gaze for experts who completed the same task. After four training sessions, the perceptual-training group significantly changed their visual search behavior to more closely resemble the highlighting sequence, and they improved their performance on a task that required a joystick to be moved to “intercept” penalty shots more than the other two groups did. Unfortunately, though, the perceptual training group also took significantly longer to initiate their joystick response following the intervention; as a result, it is unclear whether the change in performance was a result of better anticipation, or rather that participants simply waited longer to respond, providing them with more information on which to base their response.

Collectively, these studies present conflicting evidence regarding the provision of guiding information for the perceptual training of anticipatory skills. There is a clear need for additional research to help confirm the efficacy of color cueing and other means of guiding visual attention in enhancing the acquisition of expert-like perceptual skills. In this study, we investigated whether perceptual learning could be enhanced by supplementing normal training with on-screen visual information designed to guide the attention of observers. Specifically, similar to Savelsbergh et al. (2010), we used color cueing to guide novice soccer goalkeepers toward the gaze pattern used by skilled players, plus we also used on-screen visual prompts to guide attention toward the sites containing the information thought to be most critical for skilled anticipation throughout the kicking action. It was

hypothesized that perceptual training supplemented with guiding information would improve anticipatory performance above that attainable through perceptual training without guidance, and above that attainable by a control group receiving no perceptual training.

## METHOD

### Participants

Twenty-eight male university students ( $M_{\text{age}} = 22.6 \pm 2.7$  years) took part in the experiment. All had normal or corrected-to-normal vision and had no experience facing penalty kicks as a goalkeeper. The study had ethical clearance according to the relevant institutional guidelines, and informed consent was obtained prior to commencing the experiment.

### Testing and Training Materials

#### *Video Clips*

A series of video clips was recorded to display a goalkeeper's view of skilled university-level soccer players attempting penalty kicks at goal. The clips were recorded using a digital video camera (Sony DSR-420) positioned in the center of the goal at a height of 1.7 m, simulating the position in which a goalkeeper would stand in a penalty situation. Each clip was edited so that it displayed the opposing player's approach to the ball through to the moment the kicker's foot made contact with the ball. A total of 560 different video clips were recorded for use in the experiment; this included 140 clips for each of four different kick directions relative to the view of the goalkeeper, namely, (a) upper-left of the goal, (b) lower-left of the goal, (c) upper-right of the goal, and (d) lower-right of the goal. Each test clip showed footage of 1 of 11 different kickers of comparable skill level, with the clips selected to ensure that the four kick directions were evenly distributed for each of the kickers.

#### *Anticipation Test*

An assortment of video clips evenly distributed across the four kick directions was used in the anticipation test; a set of 40 clips was used for the pretest of anticipation, a set of 40 different clips were used for the posttest, and a further 20 different clips were used for the retention test. For each clip, participants were required to anticipate the direction of the kick as quickly and accurately as possible by pressing one of four response keys (corresponding to a prediction of top-left, bottom-left, top-right, and bottom-right of the goal) on a keyboard modified specifically for this experiment. A customized computer application was developed to control the presentation of video clips and to record the accuracy of the responses made by each participant as well



as the RTs. The anticipation test was administered before, immediately after, and 24 hr after the training intervention to provide an assessment of the efficacy of the interventions in improving anticipatory skill.

### Training Interventions

Video clips not used in the anticipation test were selected to create training stimuli for two different training interventions: *guided perceptual training* and *unguided perceptual training*. Each training session for the guided perceptual-training group was composed of 64 clips in total: 32 clips containing supplementary guidance and 32 clips without any supplementation to guide attention. Rather than providing supplementary guidance on all 64 clips, the mix of supplemented and nonsupplemented clips was used to prevent participants from becoming reliant on supplementary information to guide their viewing patterns and responses on every clip. The corresponding training sessions for the unguided perceptual-training intervention were composed of the same 64 clips except that they contained no supplementary guidance.

The video clips that provided supplementary guidance comprised one set of clips in which the critical kinematic information was highlighted and another set of clips in which color cueing was used to highlight the visual search strategy used by highly skilled goalkeepers. The training clips that provided guidance as to the location of critical

kinematic information were digitally edited to highlight the key features within the opposing player's kicking mechanics known to differentiate different kick directions. In each of these clips, the same sequence of semitransparent red lines, arrows, and circled patches were superimposed on the image of the player (see Figure 1a for a demonstration of the action sequence) to highlight different elements of the movement pattern known to provide sources of information utilized by skilled soccer players to anticipate penalty kicks (Franks & Harvey, 1997; Kim, Lee, & Park, 2005; Savelsbergh et al., 2002; Williams & Burwitz, 1993). Five different sources of information within the action sequence were sequentially highlighted in each of these clips: (a) the penalty taker's angle of run-up; (b) torso and hip orientation during the run-up; (c) arc and angle of the nonkicking leg during approach to the ball; (d) the hip position and orientation, the lean of the trunk, the orientation of the nonkicking leg, and the arc of the kicking leg prior to and at contact; and (e) the angle of the kicking leg and ball at foot-ball contact. In each clip, footage was paused for 2 s when each new kinematic feature was highlighted. The training clips that provided guidance toward the desired visual search strategy had a semitransparent red patch superimposed over the spatial locations that attract the gaze of skilled goalkeepers (see Figure 1b). Based on previous research examining the visual search strategies used by skilled soccer goalkeepers (e.g., Kim et al., 2005), the location of the

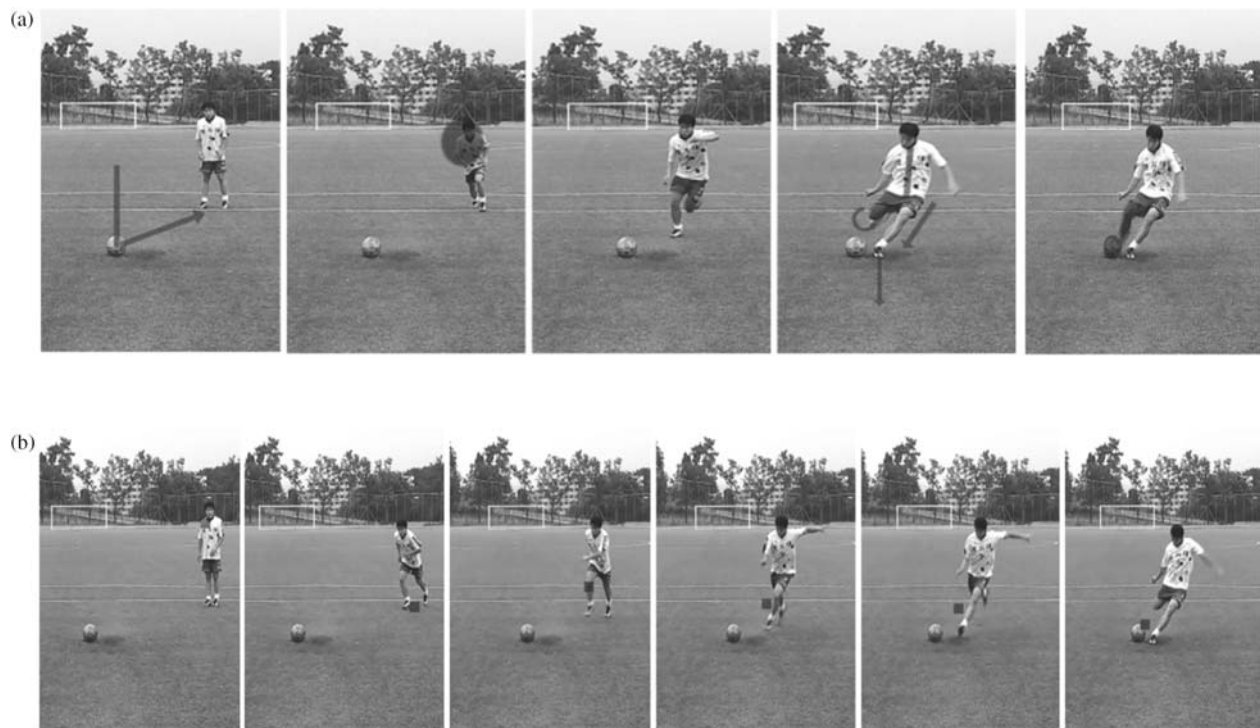


FIGURE 1 Example of screenshots from (a) a clip providing guidance on the location of the critical kinematic information for prediction, and (b) a clip highlighting the typical visual search strategy of a skilled goalkeeper. Clips containing supplementary guidance sequentially highlighted the different features within the action sequence.

color-cueing patch moved sequentially from the face, to the upper body and hips, to the nonkicking leg, and then to the kicking leg and ball at foot–ball contact. The intention of this cueing was to guide novices to modify their visual search patterns to match those used by skilled goalkeepers.

As in the anticipation tests, for each of the clips seen during the training sessions, participants were required to judge the direction of the penalty kick by pressing the button corresponding to the chosen direction as quickly and as accurately as possible.

## Experimental Design and Procedures

The experiment consisted of four phases: pretest, an intervention phase, posttest, and retention test. Participants were randomly assigned to one of three groups: a guided perceptual-training group, an unguided perceptual-training group, and a control group. Testing for each participant took a total of 10 days, with the intervention taking place over 7 days.

### Pretest Phase

The pretest involved participants from all three groups undertaking the anticipation test for the first time. Participants sat 3 m from a large screen (2.5 m × 2.3 m) and were required to anticipate the direction of the penalty shots shown in the test as quickly and as accurately as possible. Ten practice trials were performed for familiarization prior to the test proper. The 40 trials contained within the test consisted of 10 kicks to each of the four corners of the goal and were presented in a random order with no feedback on performance.

### Intervention Phase

The intervention phase consisted of seven training sessions with one training session per day during 7 consecutive days. Participants ( $n = 9$ ) assigned to the guided perceptual-training group viewed 64 clips in each training session: 32 clips with supplementary guidance and 32 clips with no supplementary guidance. Feedback on whether the response was correct was provided only on the 32 training clips containing supplementary guidance. Participants ( $n = 10$ ) assigned to the unguided perceptual-training group viewed 64 training clips without guidance in each session and received feedback on the same 32 clips for which the guided perceptual-training group received feedback. Participants in the control group ( $n = 9$ ) had no form of training during the intervention phase. Each training session for the two perceptual-training groups took approximately 40 min to complete.

### Posttest and Retention Test Phase

Posttesting was performed in an identical fashion to the pretest, with participants required to anticipate ball direction

for a set of 40 clips derived from the same players but different from those shown in the pretest. After 24 hrs a retention test was performed following the same test procedure, except that on this occasion, only 20 trials were presented to compare to pretest and posttest performance. The purpose of the retention test was to determine whether any improvements in response accuracy (RA) as a result of the intervention period would be maintained following a 24-hr retention interval.

## Dependent Variables and Data Analysis

RA and RT were recorded as dependent variables. RA was calculated as the percentage of trials in which the participant correctly anticipated the direction of the kick. RT was the time (in milliseconds) elapsed from the moment of foot–ball contact to the participant's button-press response. Prior to analysis, the RT data were first subjected to a test of normality. Four participants (one participant from the guided perceptual-training group, two participants from the unguided perceptual-training group, and one participant from the control group) who demonstrated consistently slow mean response times ( $> 1.0$  s) were identified as being outliers. Because the RT data were normally distributed when these four participants were excluded, the data from these four participants were excluded from all further analyses, leaving an even sampling of eight participants per group. A 3 (group) × 3 (time of testing) analysis of variance (ANOVA) with repeated measure on the second factor was used to analyze changes in RT and RA before and after the training intervention. To account for the possibilities of differences in speed–accuracy trade-off across the three test phases, differences in the RA data between successive testing sessions were calculated and subjected to an analysis of covariance (ANCOVA) using the differences in RT as a covariate. Further, the training data for the two intervention groups were subjected to a 2 (group) × 7 (training session) ANOVA with repeated measure on the second factor to examine changes in RA and RT within the training intervention. We applied a Greenhouse-Geisser correction to the degrees of freedom in the case of any violations of sphericity. Significant effects were followed up using Tukey's post-hoc tests, and the alpha level for significance was set at  $p = .05$  for all statistical comparisons.

## RESULTS

### Performance Compared Before and After the Intervention Phase

#### Response Accuracy

Significant main effects were observed for group,  $F(2, 21) = 24.77$ ,  $p < .001$ ,  $\eta_p^2 = .70$ , time of testing,  $F(2, 42) = 18.44$ ,  $p < .001$ ,  $\eta_p^2 = .47$ , and for the Group ×

Time of Testing interaction,  $F(4, 42) = 9.76, p < .001, \eta_p^2 = .48$  (see Figure 2a). Post-hoc analyses revealed that when compared with performance in the pretest, the guided perceptual-training group was more accurate on both the posttest ( $p = .002$ ) and retention test ( $p < .001$ ). In contrast, the unguided perceptual-training group was not more accurate in the posttest ( $p = .22$ ), but they did show a significant improvement from pretest to the retention test ( $p = .019$ ). There was no significant change in the performance of the control group from pretest to posttest, or from pretest to the retention test (both  $ps > .05$ ). The guided perceptual-training group showed more accurate responses compared with the unguided perceptual-training

and control groups in the posttest (both  $ps < .001$ ) and in the retention test (guided vs. unguided,  $p = .008$ ; guided vs. control,  $p < .001$ ), but there were no differences between groups in the pretest ( $ps > .05$ ). The unguided perceptual-training group showed more accurate responses compared with the control group in the retention test ( $p < .001$ ), but not in the pretest or posttest (both  $ps > .05$ ).

### Response Time

There were no significant main effects for group,  $F(2, 21) = 1.27, p = .30, \eta_p^2 = .11$ , or time of testing,  $F(1.22, 25.60) = 3.40, p = .069, \eta_p^2 = .14$ , nor was there any

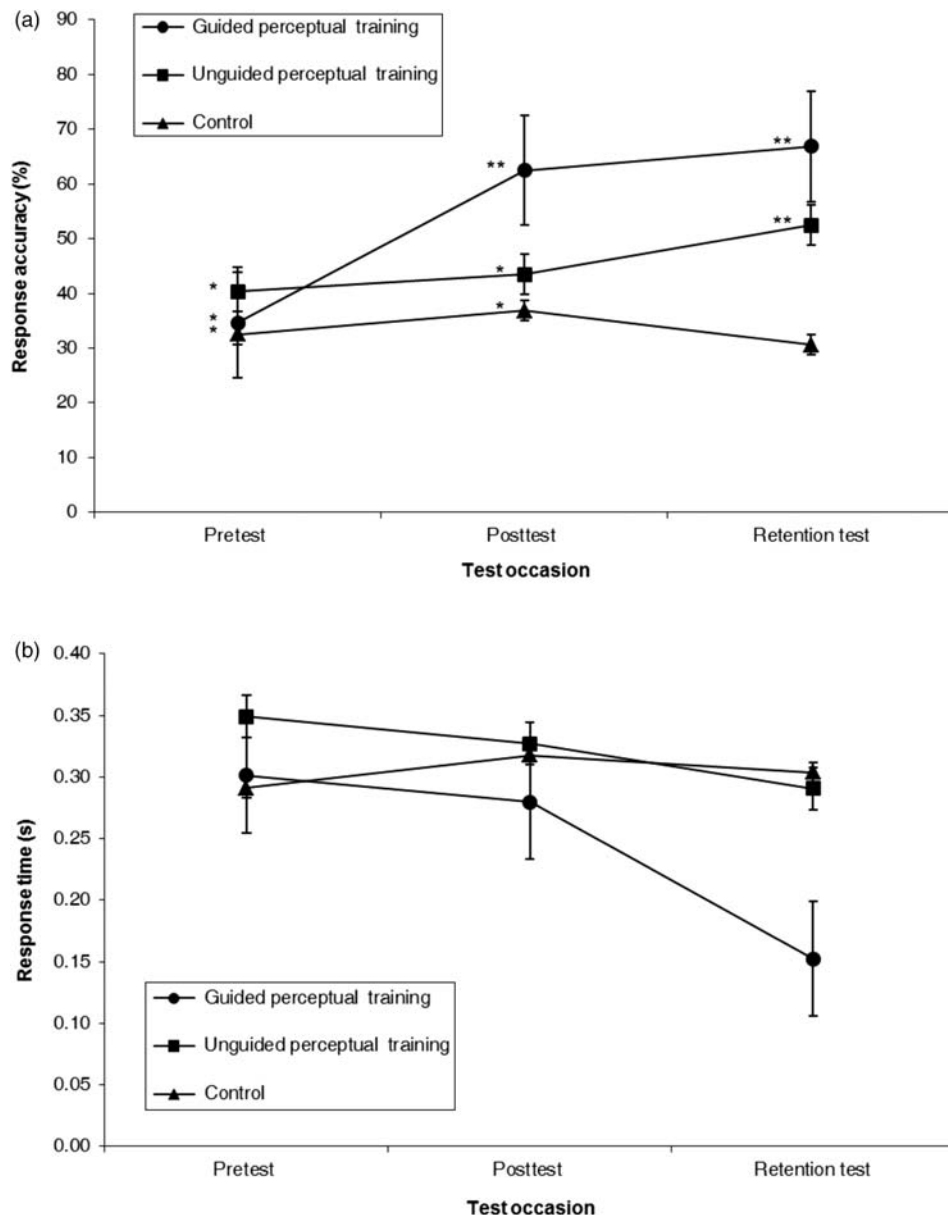


FIGURE 2 Mean (a) response accuracy scores, and (b) response times on the pretest, posttest, and retention test for each of the three groups (showing standard error bars). Data points are shown in Figure 2a which are greater than the 25% level achievable by chance guessing (\*  $p < .05$ ; \*\* $p < .001$ ).



significant interaction between group and time of testing,  $F(2.44, 25.60) = 1.61$ ,  $p = .22$ ,  $\eta_p^2 = .13$  (see Figure 2b).

### Speed–Accuracy Covariate Analysis

Although there were no significant main or interaction effects for the RT dependent variable, a covariate analysis was still deemed necessary in light of the marginal main effect for time of testing ( $p = .069$ ), and considering the previous ambiguity as to whether cueing-based improvements in performance are related to improved anticipation or whether they are a result of a change in RT (see Savelsbergh et al., 2010).

**Pretest versus posttest.** The covariate variable, change in RT from pretest to posttest, was significantly related to the change in RA from pretest to posttest,  $F(1, 20) = 4.60$ ,  $p < .05$ . After controlling for the effect of RT, a significant effect for group was still found,  $F(2, 20) = 14.52$ ,  $p < .001$ ,  $\eta_p^2 = .59$  (see Figure 3a). The simple contrasts revealed that the guided perceptual-training group improved significantly more than did the control group from pretest to posttest ( $p < .001$ ), but the unguided perceptual-training group did not ( $p = .95$ ). The guided perceptual-training group improved significantly more than did the unguided perceptual-training group ( $p < .001$ ).

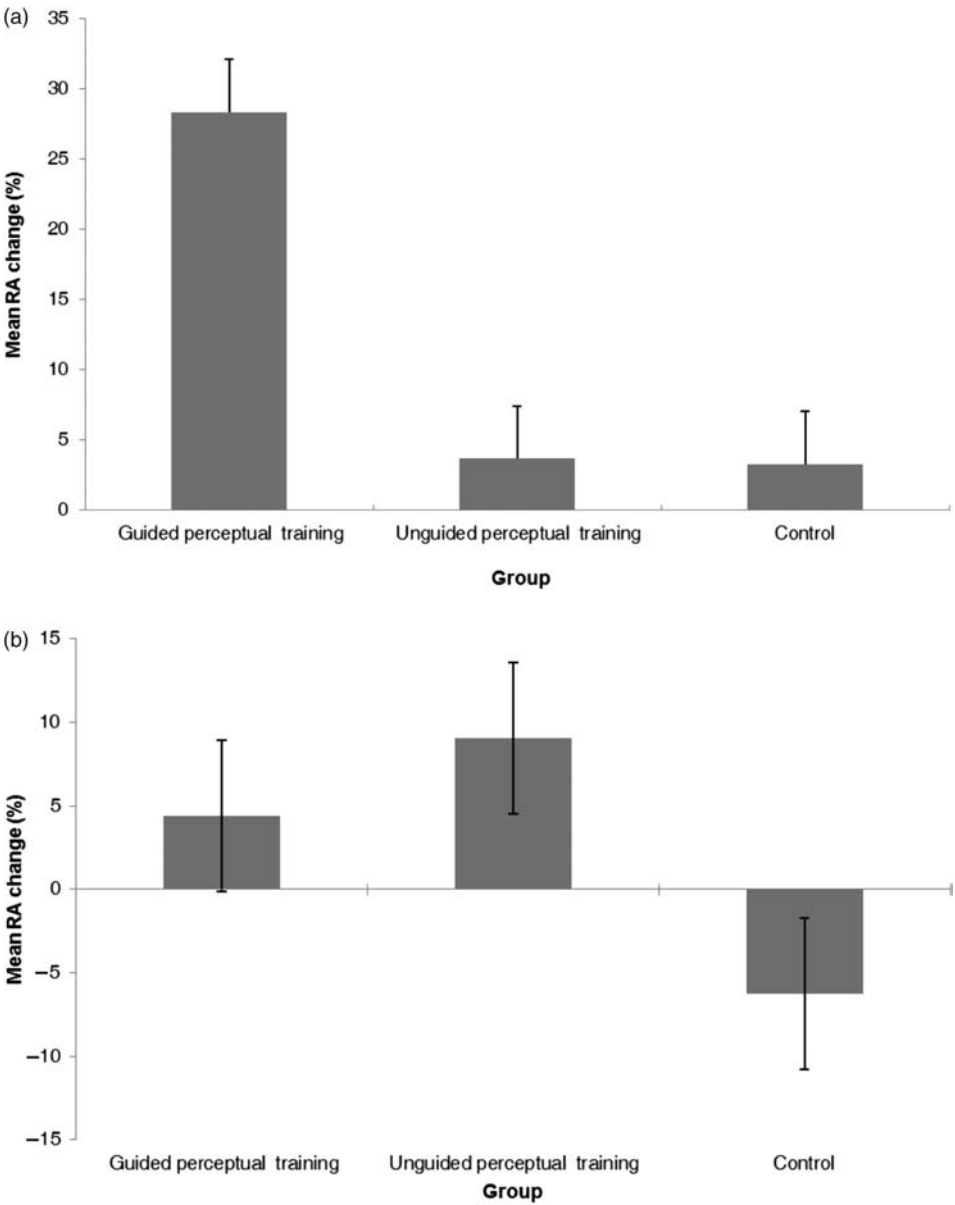


FIGURE 3 Mean change in response accuracy (RA) for each of the three groups from (a) pretest to posttest, and (b) posttest to retention test, shown with standard error bars.

**Posttest versus retention test.** ANCOVA revealed that the covariate change in RT from posttest to retention test was not a significant predictor of change in RA from posttest to retention test, so it was removed from the analysis. Changes in RA from posttest to the retention test were significantly different between the three groups,  $F(2, 21) = 3.72, p = .042, \eta_p^2 = .26$  (see Figure 3b). The simple contrasts revealed that the unguided perceptual-training group improved significantly more compared with the control group from posttest to retention test ( $p = .015$ ), but the guided perceptual-training group did not ( $p = .079$ ). There was no difference in improvement between the guided and unguided perceptual-training groups ( $p = .43$ ).

## Performance During the Intervention Phase

### Response Accuracy

Significant effects were observed for training session,  $F(6, 84) = 8.72, p < .001, \eta_p^2 = .38$ , and for the Group  $\times$  Training Session interaction,  $F(6, 84) = 3.94, p = .002, \eta_p^2 = .22$ , but there was no main effect of group,  $F(1, 14) = 1.44, p = .25, \eta_p^2 = .09$  (see Figure 4a). Post-hoc analyses revealed that the superiority of the guided perceptual-training group only emerged later in the intervention phase, with their RA being higher than the unguided group at the sixth and seventh training sessions ( $ps < .05$ ), but not for the earlier training sessions ( $ps > .05$ ).

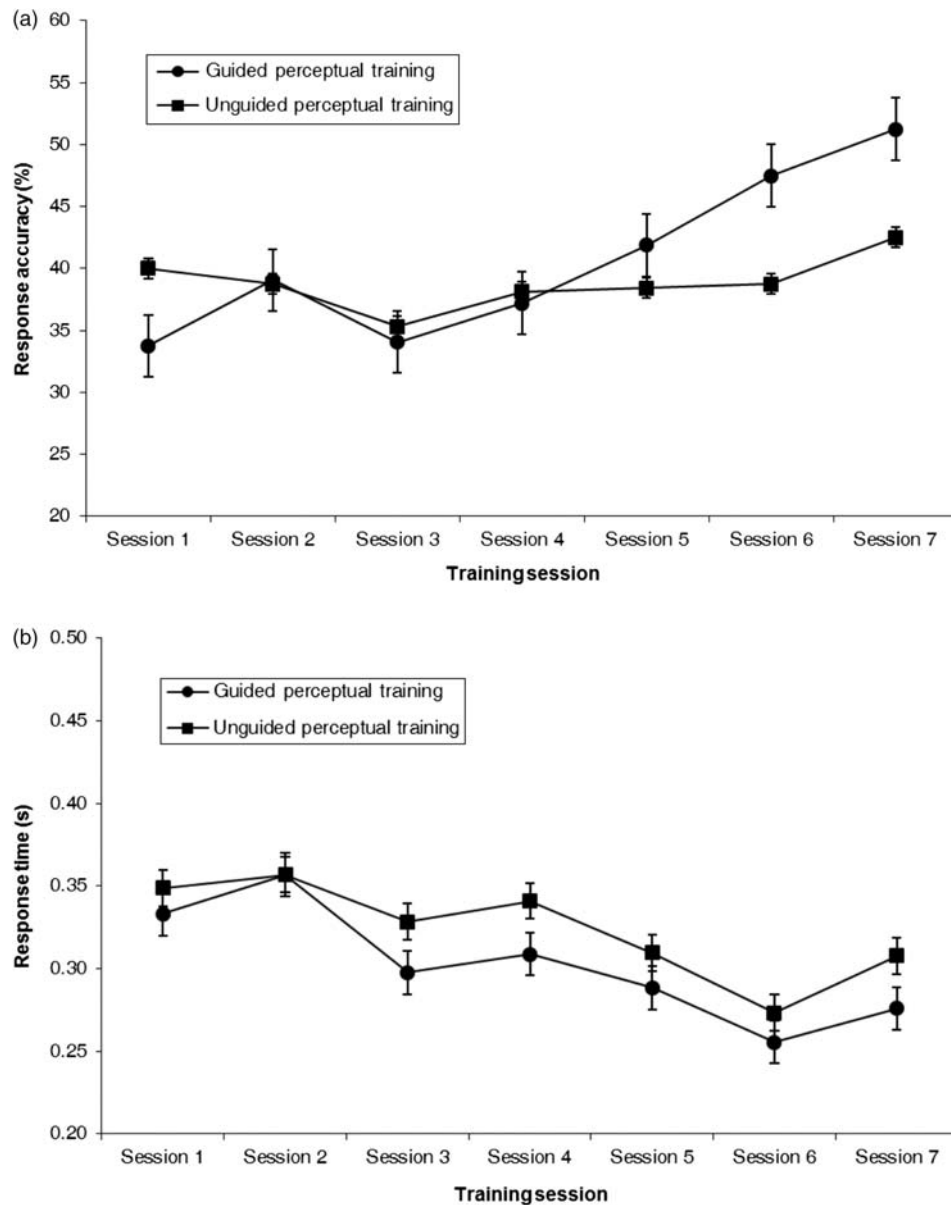


FIGURE 4 Mean (a) response accuracy scores and (b) response times during training sessions for each of the two training groups. Data are shown with standard error.

### Response Time

There were no significant main effects for group,  $F(1, 14) = 0.10$ ,  $p = .76$ ,  $\eta_p^2 = .01$ , or training session,  $F(2.49, 34.89) = 1.04$ ,  $p = .38$ ,  $\eta_p^2 = .07$ , nor was there any significant interaction between group and training session,  $F(2.49, 34.89) = 0.21$ ,  $p = .86$ ,  $\eta_p^2 = .02$  (see Figure 4b).

## DISCUSSION

In this study, we examined whether supplementing perceptual-skill training with guiding visual information would enhance perceptual-skill learning in novice soccer goalkeepers. Given the conflicting findings from previous studies that have attempted to use cueing to help guide attention (Abernethy et al., 2012; Hagemann et al., 2006; Savelsbergh et al., 2010), the key point of interest was to establish whether guided perceptual training, when experienced in combination with normal (unguided) training clips, would be effective in improving anticipatory performance. We predicted that following a training intervention, the guided perceptual-training group would demonstrate a greater capability to anticipate penalty kick placement compared with either the group experiencing unguided perceptual training or the control group, and we predicted that this would be the result of a genuine improvement in performance rather than a reflection of a change in RT (cf. Savelsbergh et al., 2010).

The findings of this study revealed an improvement in prediction accuracy for the guided perceptual-training group at both the posttest and retention test that was not evident for the control group. Although the unguided perceptual-training group was more accurate than the control group at the retention test, the accuracy of the guided perceptual-training group was higher than it was for the unguided perceptual-training group in both the posttest and retention test. These findings not only support previous studies reporting the positive effects of perceptual-skill training (e.g., Franks & Harvey, 1997; McMorris & Hauxwell, 1997), but they demonstrate that some forms of perceptual training are more successful than others (cf. Abernethy et al., 2012; Hagemann et al., 2006; Savelsbergh et al., 2010). The guided and unguided perceptual-training groups experienced the same amount of training, had the same availability of feedback, and viewed precisely the same clips; this provides strong evidence that the guidance provided by the cueing to the key kinematic information and the expert search strategy was the key factor in improving anticipatory performance. Importantly, the improvements in RA were independent of changes in RT, a result that helps to provide some confidence that the results of Savelsbergh et al. (2010) may have been genuine improvements in RA, rather than artifacts based on a delayed response. The data for the

training sessions suggest that at least six training sessions (i.e., about 384 trials) were necessary before the benefits of guidance supplementation began to emerge. This is a surprisingly high number of trials and may help, at least in part, to explain why previous studies have produced conflicting results with respect to the benefits of cued guidance of attention. Of course in our study, only half of these trials contained guiding information. Having established the benefit of supplementing perceptual-training stimuli with guiding visual information, future work can seek to establish the most efficacious proportion of trials that should be incorporated to facilitate learning while ensuring that observers are not entirely reliant on this cueing information.

It has been clearly demonstrated during the last 20 years that skilled sportspeople rely on superior perceptual skills to underpin their level of expertise, and the results of the current study help to support the notion that lesser-skilled athletes can learn these skills. Although the performance of the unguided perceptual-training group was inferior to that of the guided group, an advantage was still apparent for the unguided training group at retention testing. This result provides some support for the efficacy of unguided perceptual training, though it suggests that this may not be the most efficacious and time-efficient means of doing so. Specific and guided information can help to accelerate the learning of this important element of expertise. With appropriate training, it appears that novices are indeed able to attain more refined task-specific knowledge structures and an improved strategic processing of information to become more "expert-like." A key question that remains, though, is whether the anticipatory skills shown to improve in simulated (i.e., video-based) tests lead to commensurate improvements in on-field anticipatory performance. Simulated experimental conditions are known to underestimate the expert advantage in anticipatory responses (Mann, Abernethy, & Farrow, 2010) and alter the visual search strategy evident in a normal in-situ environment (Dicks et al., 2010). From a theoretical standpoint, this raises doubt as to whether anticipatory skills learned in a video-based task will effectively result in enhanced on-court performance. Yet, a growing number of empirical studies have shown otherwise. These studies have demonstrated that anticipatory skills learned using video simulations do generalize to on-court situations (e.g., Farrow & Abernethy, 2002; Hopwood, Mann, Farrow, & Nielsen, 2011; Williams, Ward, & Chapman, 2003; Williams et al., 2002). Clearly, though, there is a need for future work to establish the degree and specificity of video-based training that is necessary to result in meaningful improvements in on-court performance.

In this study, based in part on the work of Hagemann et al. (2006) and Savelsbergh et al. (2010), innovative methodological interventions were used to guide novice soccer players to use essential kinematic cues and expert-

like visual gaze patterns to improve their game-specific anticipatory skills. An attempt was made to move toward an informative intervention that sought to guide the learning of individuals, while not providing highly verbal and/or explicit instructions about the important information to interpret movement. The growing body of literature supporting the effectiveness of perceptual training provides an important foundation for future work to establish the most effective forms of perceptual training, the time scale for improvements in performance, the development of ecologically valid protocols to incorporate the important link between perception and action, and the effectiveness of these programs in enhancing the on-field performance of developing athletes. In particular, it is important for future work to resolve the relative contribution of the two different forms of guidance used in this study and to evaluate their respective usefulness in prospective perceptual-training programs. Further, it is always important to consider whether the benefits apparent from this type of perceptual training result in direct improvements in on-field performance (cf. Hopwood et al., 2011).

#### WHAT DOES THIS ARTICLE ADD?

Perceptual training is an increasingly important topic in sport science. Thus far, numerous attempts have been made to find the most effective and time-efficient means of learning perceptual skills. One approach that offers promise is to guide learners to adapt an appropriate attentional set to develop the perceptual skills of experts. Guidance might be provided either through highlighting the critical kinematic (body-related) cues within the display, or by highlighting the body areas that reflect the gaze strategies that experts adopt when doing the same task. Thus far, the evidence as to the effectiveness of color cueing is mixed. This study examined this notion using a protocol in which perceptual training was supplemented by guidance to the critical kinematics and to the expert gaze pattern for the clip being viewed. The article adds evidence that perceptual training *with suitable guidance of attention* can improve the learning of key perceptual skills such as anticipation. This is important practically for the design of improved training approaches that might be applicable to a wide range of sports and to other movement-related activities.

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